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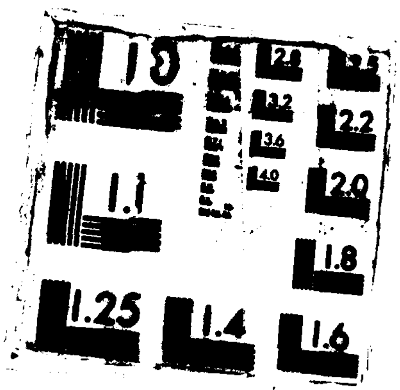

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REMARKS (Continue on reverse)

1. Enclosure (1), revised April 1987, updates and supersedes the Norfolk section originally provided in the basic volume of Hurricane Havens Handbook for the North Atlantic Ocean, NAVENVPREDRSCHFAC TR 82-03 of June 1982.

2. Recipients not holding the basic volume or changes 1 or 2 may request these previously distributed publications by letter to this command addressed as in FROM block above, attention technical library.

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II. NORFOLK, VIRGINIA

SUMMARY

Tropical cyclones capable of maintaining sustained winds of hurricane force (~~greater than~~ 63 kt) are possible, although rare, at the Norfolk harbors. This stems from the particular combination of Norfolk's ~~high~~ latitude and the orientation of the coastline which provides protection from the more vigorous tropical cyclones. Nevertheless, none of the harbors in the Norfolk area are safe havens during hurricane force winds. Although the harbors will provide protection and have provided safe anchorage for some smaller ships during such conditions, ships with large sail areas (generally larger than frigate size) will drag anchor, and therefore should evade at sea. Smaller vessels, other than fishing boats and sailing crafts, and those disabled by mechanical problems may ~~also~~ seek shelter in the Norfolk Shipyard or other locations along the southern branch of the Elizabeth River. Smaller ships unable to tie up at piers may ~~make~~ use ~~of~~ designated hurricane anchorages in Chesapeake Bay. They should be aware, however, that ~~the land~~ land in the region is very flat ~~in the region~~ and there are few radar targets to use ~~in~~ establish~~ing~~ accurate ship position. In winds of hurricane force visibility is near zero so visual determination of position is impossible. ~~The~~ above guidance includes a consideration of the following factors:

(a) The topography of the area is entirely flat and provides very little sheltering from the winds.

(b) There is good shelter from wave action in all the harbors except the Naval Station with westerly winds.

(c) There is a significant threat of storm surge.

It is recommended that ships take action as described above at an early stage in a threat situation due to the particularly difficult evasion routes that are likely to be available, and time delays likely to occur in leaving port (tug shortages, blocking traffic, etc.)

NOTE: In September 1985, Hurricane Gloria struck the Norfolk area while several US Navy ships were at hurricane anchorages in Chesapeake Bay. All but the smaller ships dragged anchor (some several hundred yards) and some came close to going aground. Considerable time and effort went into studying the lessons learned from this incident. Hurricane anchorages in the Chesapeake Bay were expanded from a 2000-yard diameter to a 3000-yard diameter, and anchorages too close to shallow water have been deleted. Because ships of recent design have large sail areas, they tend to be 'pushed sideways' rather than weathervane with the wind, making control difficult and, in many cases, impossible. Consequently, ships frigate size and larger would be safer evading at sea if possible.

NORFOLK, VA

1. GEOGRAPHIC LOCATION

Figure II-1 shows the general areas of Norfolk, situated in the southeast corner of the State of Virginia at the southern end of Chesapeake Bay. The major local naval activities of the Norfolk complex are depicted. Figure II-2 is a detailed map of the Norfolk Naval Station showing the individual pier locations.

2. THE HARBORS AND THEIR FACILITIES

2.1 NAVAL STATION, NORFOLK (Figure II-2)

Norfolk Naval Station lies at the eastern shore of Hampton Roads. Hampton Roads is a natural tidal basin formed by the confluence of the James and Elizabeth Rivers. The entrance to Hampton Roads for all deep draft ships lies between Old Point Comfort and Fort Wool (see Figure II-1). Not only is Hampton Roads the gateway to the Naval Station, but also provides access to commercial and naval activities at Norfolk and Portsmouth on the Elizabeth River, extensive shipbuilding and cargo handling facilities at Newport News, and many smaller facilities and marinas along the James and Elizabeth Rivers. Therefore, the whole area is extremely busy with marine traffic.

The Norfolk area, being the largest concentration of naval activity on the east coast of the United States, has a large number of berths, anchorages, facilities and services available. The reader is referred to the following publications for complete details:

DMA Hydrographic/Topographic Center Publication 940 Chapter 5,
Fleet Guide to Hampton Roads
Chart 12221, Chesapeake Bay Entrance
Chart 12245, Hampton Roads
U.S. Department of Commerce, United States Coast Pilot 3.
Atlantic Coast: Sandy Hook to Cape Henry

2.2 NAVAL AMPHIBIOUS BASE, LITTLE CREEK (Figure II-1)

Little Creek is a small inlet on the southern shore of Chesapeake Bay approximately 10 miles east of the naval station. Ships with 20 ft draft, i.e., LSD, LPD, LKA (lightly loaded), routinely use Little Creek. The reader is referred to the following publications for details of the harbor and its facilities:

DMA Hydrographic/Topographic Center Publication 940 Chapter 5,
Fleet Guide to Hampton Roads
Chart 12221, Chesapeake Bay Entrance
Chart 12255, Naval Amphibious Base - Little Creek
U.S. Dept. of Commerce, United States Coast Pilot 3,
Atlantic Coast: Sandy Hook to Cape Henry

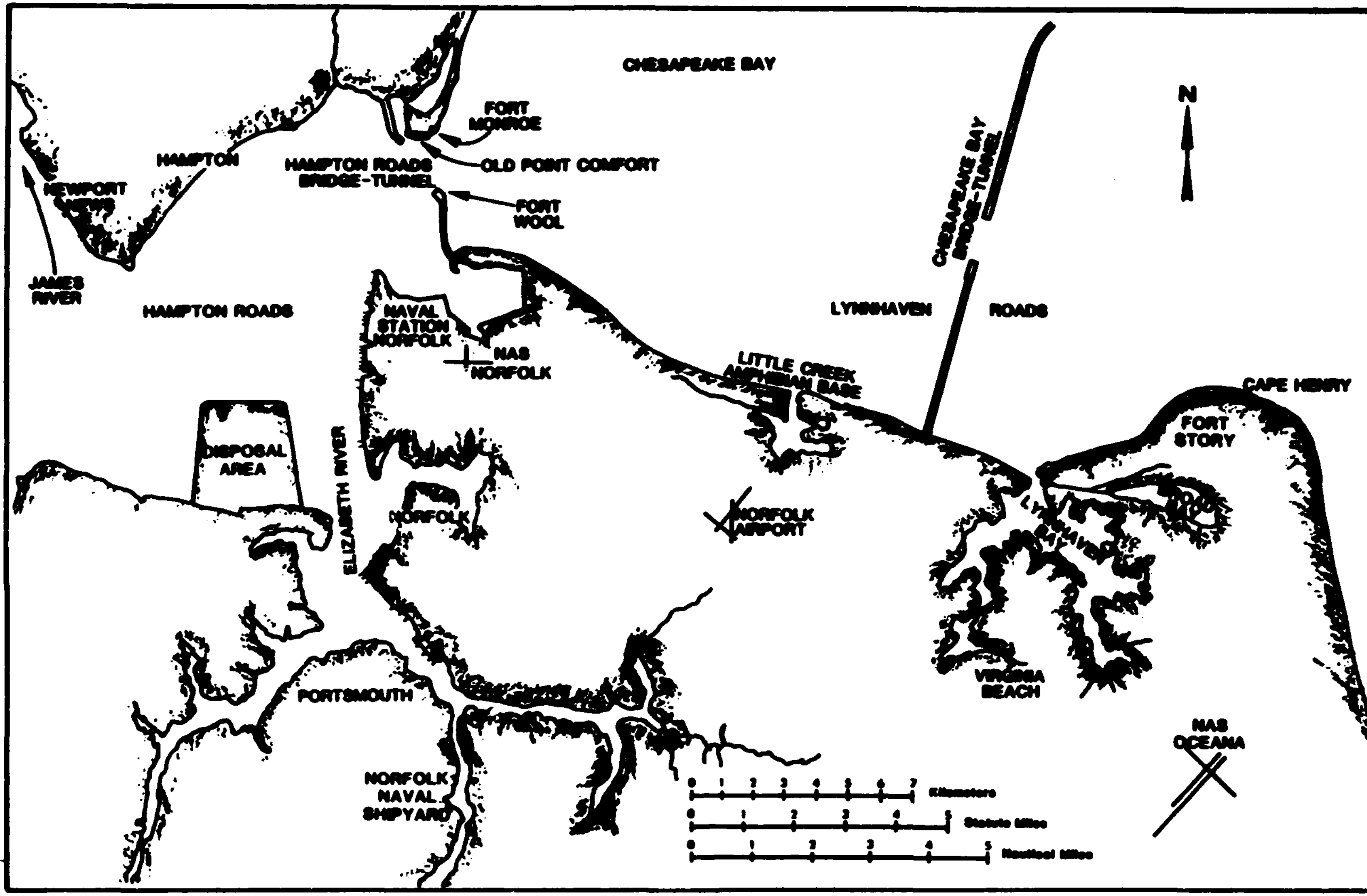

Figure II-1. Norfolk and vicinity, showing locations of naval activities.

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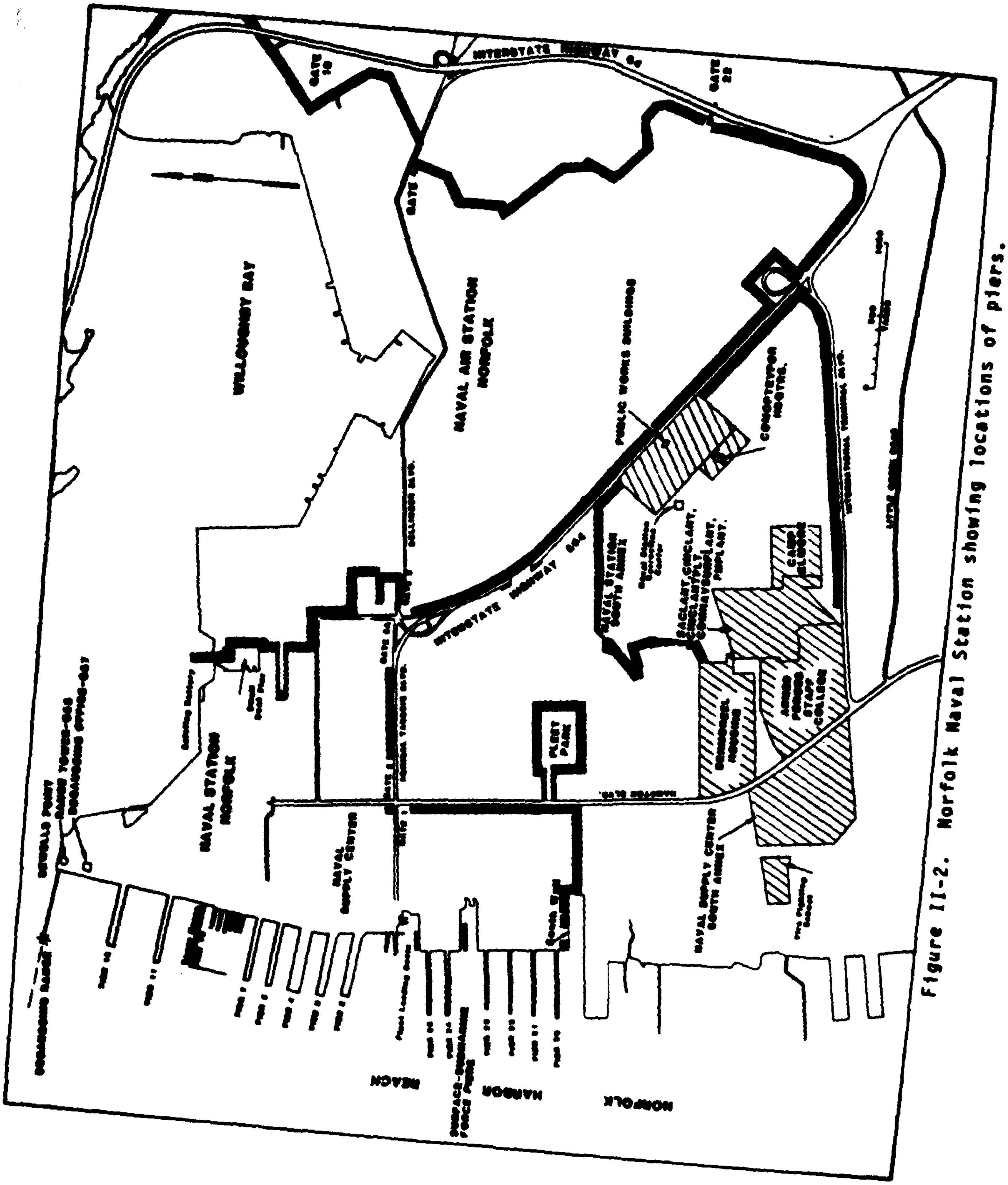

Figure II-2. Norfolk Naval Station showing locations of piers.

2.3 NORFOLK NAVAL SHIPYARD (FIGURE II-1)

The Norfolk Naval Shipyard is situated along the southern branch of the Elizabeth River, approximately five miles south of the naval station. It can accept ships of any draft at any stage of the tide. Again, the reader is referred to the following publications for details of the harbor and its facilities:

DMA Hydrographic/Topographic Center Publication 940 Chapter 5,
Fleet Guide to Hampton Roads
Chart 12221, Chesapeake Bay Entrance
Chart 12253, Norfolk Harbor and Elizabeth River

3. HEAVY WEATHER FACILITIES AND HURRICANE ANCHORAGES

3.1 TUG AVAILABILITY

Commanding Officers of vessels who may be required to shift berth, move to an anchorage, or put to sea in the event of a tropical cyclone affecting the Norfolk area should bear in mind that the services of the limited number of tugs will be at a premium before and after the passage of a tropical cyclone. Demand for tugs will be particularly high at certain stages of the tide and during normal working hours. Calls for towage assistance, especially for smaller vessels, should therefore be kept to a minimum.

3.2 HURRICANE ANCHORAGES

Hurricane anchorages have been designated in the central part of Chesapeake Bay. One set of anchorages lies in the south central area of the bay (Figure II-3), and a another set of anchorages lies in the north central area of the bay (Figure II-4). The relevant charts are 12221, Chesapeake Bay Entrance; 12225, Chesapeake Bay-Wolf Trap to Smith Point; and 12230, Chesapeake Bay-Smith Point to Cove Point. All hurricane anchorages are 3000 yards in diameter and are allocated using the following guidelines:

(1) Norfolk Sub-Area: Anchorages 0A through 12B and A through E.
(2) Little Creek Sub-Area: Anchorages 13A through 14B, F1 through F8, and G1 through G4.
(3) Hurricane Anchorages will not be assigned to submarines.
(4) Anchorages will be assigned to USCG ships if requested by Coast Guard authorities.

Order of departure, time interval and anchorage assignments are made as early as possible for planning purposes. Sortie is executed on order of SOPA Hampton Roads. Ships and afloat staff should be familiar with COMNAVBASENORVA/SOPA (ADMIN) HAMPINST 3141.1 (series) DESTRUCTIVE WEATHER PLAN which contains

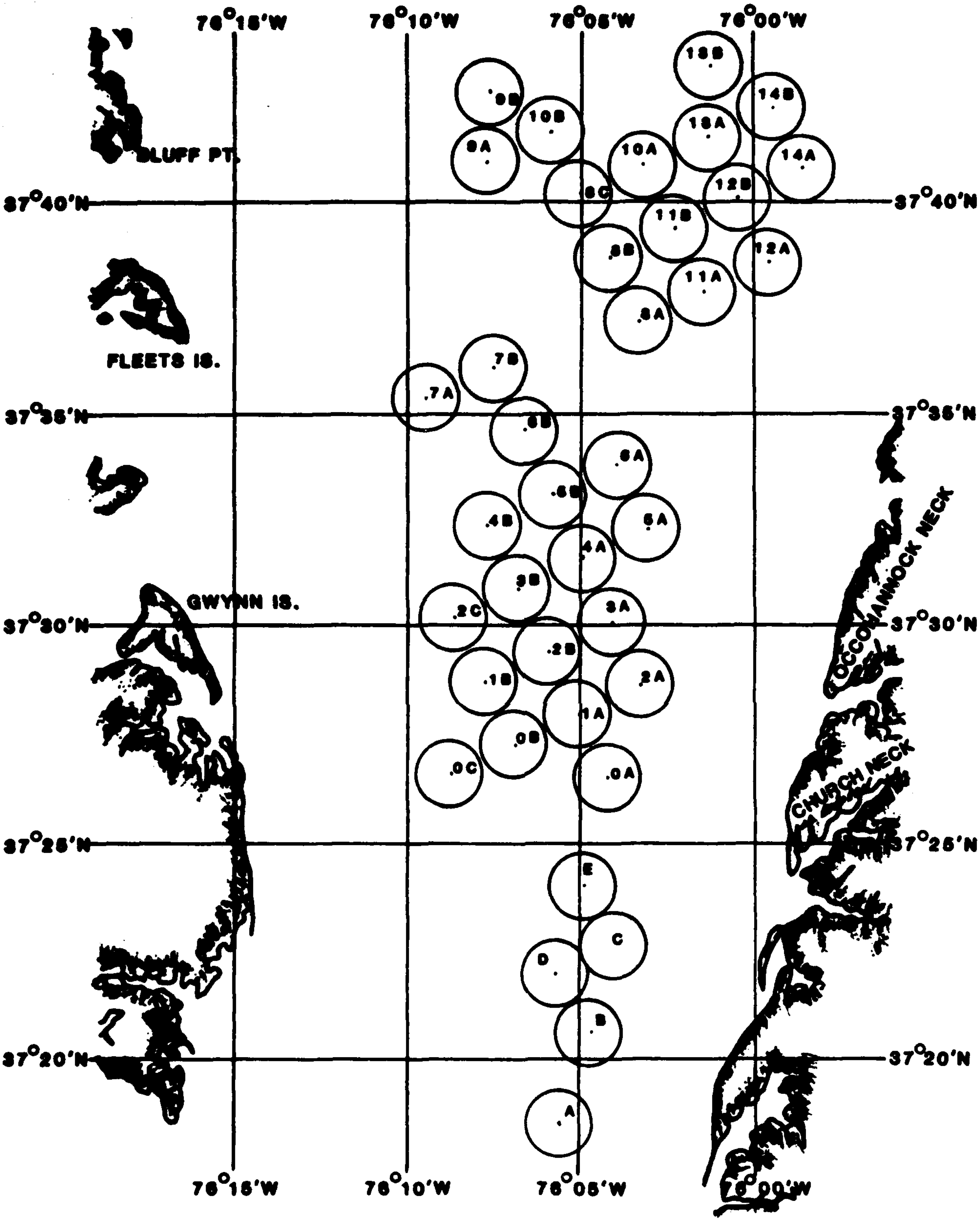

Figure II-3. Layout of anchorages in south-central Chesapeake Bay.

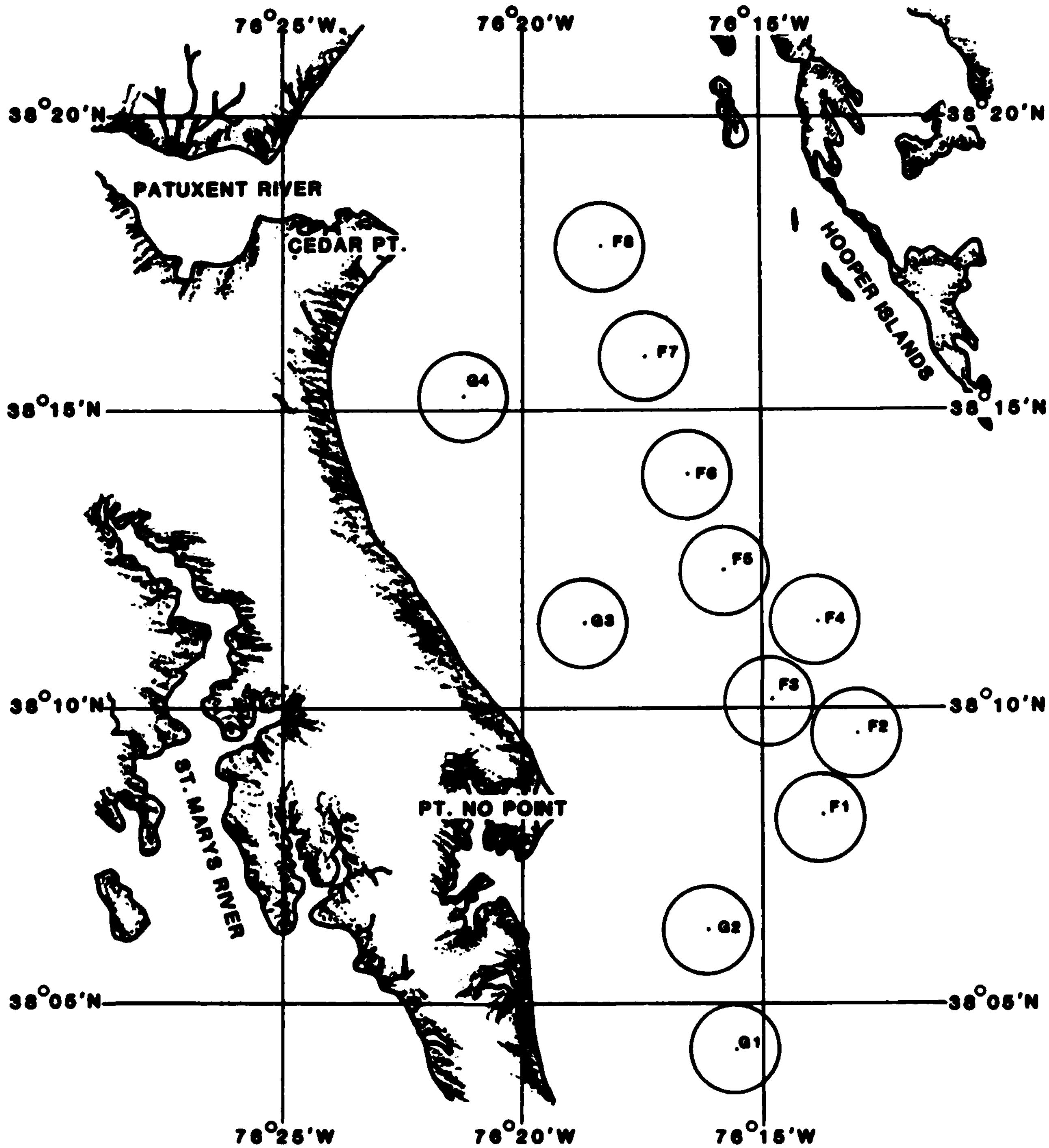

Figure II-4. Layout of anchorages in north-central Chesapeake Bay.

instructions for hurricane measures in the Hampton Roads area. SOPA sets hurricane/tropical storm conditions for ships and initiates order movements to hurricane anchorages when anticipated winds indicate such action is prudent.

4. TROPICAL CYCLONES AFFECTING NORFOLK

4.1 CLIMATOLOGY

For the purposes of this study, any tropical cyclone approaching within 180 n mi of Norfolk is considered a threat. It is recognized that a few tropical cyclones that did not approach within this distance may have affected Norfolk in some way, but a criterion had to be established for this report.

Although tropical cyclones have occurred in the North Atlantic during most of the year, the majority of those which threaten Norfolk occur from August to October. Figure II-5 shows the monthly summary of tropical cyclone occurrences based on data for the 41 years from 1945 to 1985. Of the 64 tropical storms which threatened Norfolk in the period (less than two threats per year), 59 occurred in the period between June and October with the peak threat during August/September.

Figure II-6 presents the above storms as a function of the compass octant from which they approached Norfolk. The open numbers indicate the number of cyclones which approached from that octant. The numbers in parentheses represent the same information, but as a percentage. It is evident from this figure that the majority of cyclones approach Norfolk from the south.

Approximately 1.6 tropical cyclones a year pose a threat to Norfolk. Since Norfolk lies at such a high latitude (37°N) most of these cyclones are in the process of recurving from a westerly track onto a more northerly track. During this process, the tropical cyclones tend to accelerate their forward movement to an average speed of 16 kt to 18 kt at closest point of approach (CPA) for those storms approaching from the south and southwest. Those storms which are still on a westerly or northwesterly track have an average forward speed of only 10 kt to 12 kt in this region. The direction the storm passes at CPA is important because storms to the west (over land) will tend to weaken.

Figures II-7 to II-10 are statistical summaries of threat probability based on tropical cyclone tracks for the years 1945 to 1985. The data are presented monthly during the main portion of the hurricane season, August through October (Figures II-7, II-8 and II-9). Figure II-10 is for the remainder of the year and Figure II-11 is for the whole year. The solid lines represent the "percent

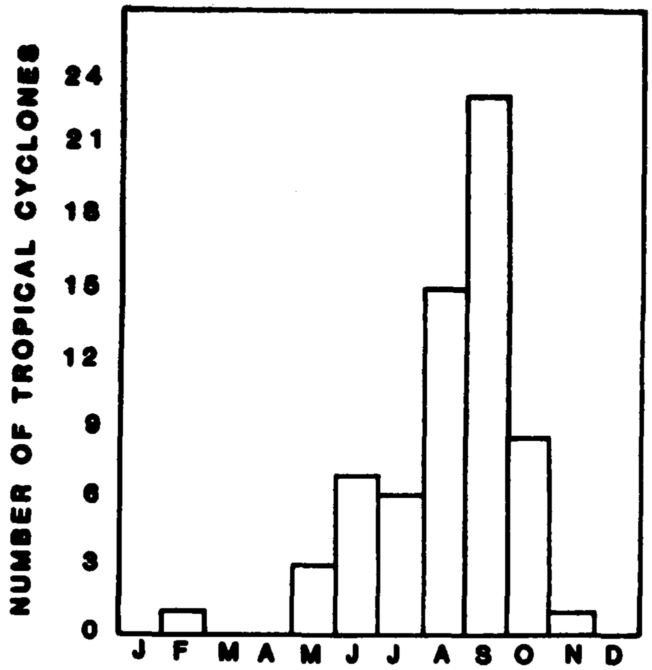

Figure II-5. Frequency distribution of tropical cyclones that passed within 180 n mi of Norfolk during the period 1945-85.

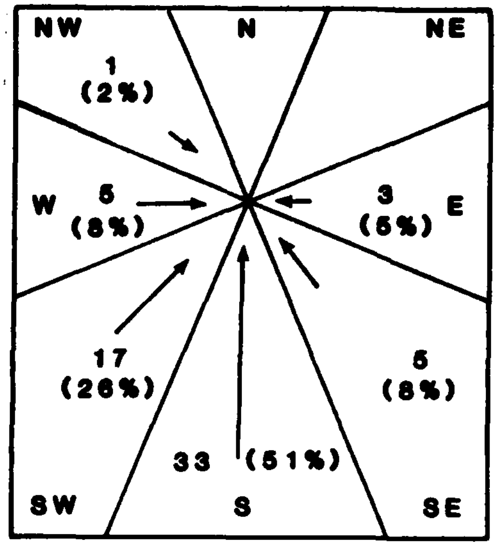

Figure II-6. Direction of approach of tropical cyclones that passed within 180 n mi of Norfolk during the period 1945-85. Numerals are the number of tropical cyclones approaching from each octant. Percentages in () are percent of the total sample of 64 storms that approached from each octant.

threat" for any storm location. The dashed lines represent approximate approach times to Norfolk based on the climatological approach speed for the particular area and direction of movement. For example, in Figure II-7, a tropical cyclone located at 25°N and 66°W has approximately a 40% probability of passing within 180 n mi of Norfolk and will reach Norfolk in 3 to 4 days if the speed remains close to the climatological normal. It can be noted from Figures II-7 to II-9 that at the beginning of the main hurricane season in August, the major threat axis is a curve from just east of the Lesser Antilles passing north of the Bahamas and then recurving up to the North Carolina coast. As the season progresses, the threat axis rotates clockwise so that by October, it follows a line from the Yucatan Channel, across the Gulf of Mexico and Florida to approach Norfolk from the southwest. During the remaining months of the year (Figure II-10), a combination of the above two axes is evident. As a consequence, the yearly profile (Figure II-11) embodies both the southeasterly and southwesterly threat axes.

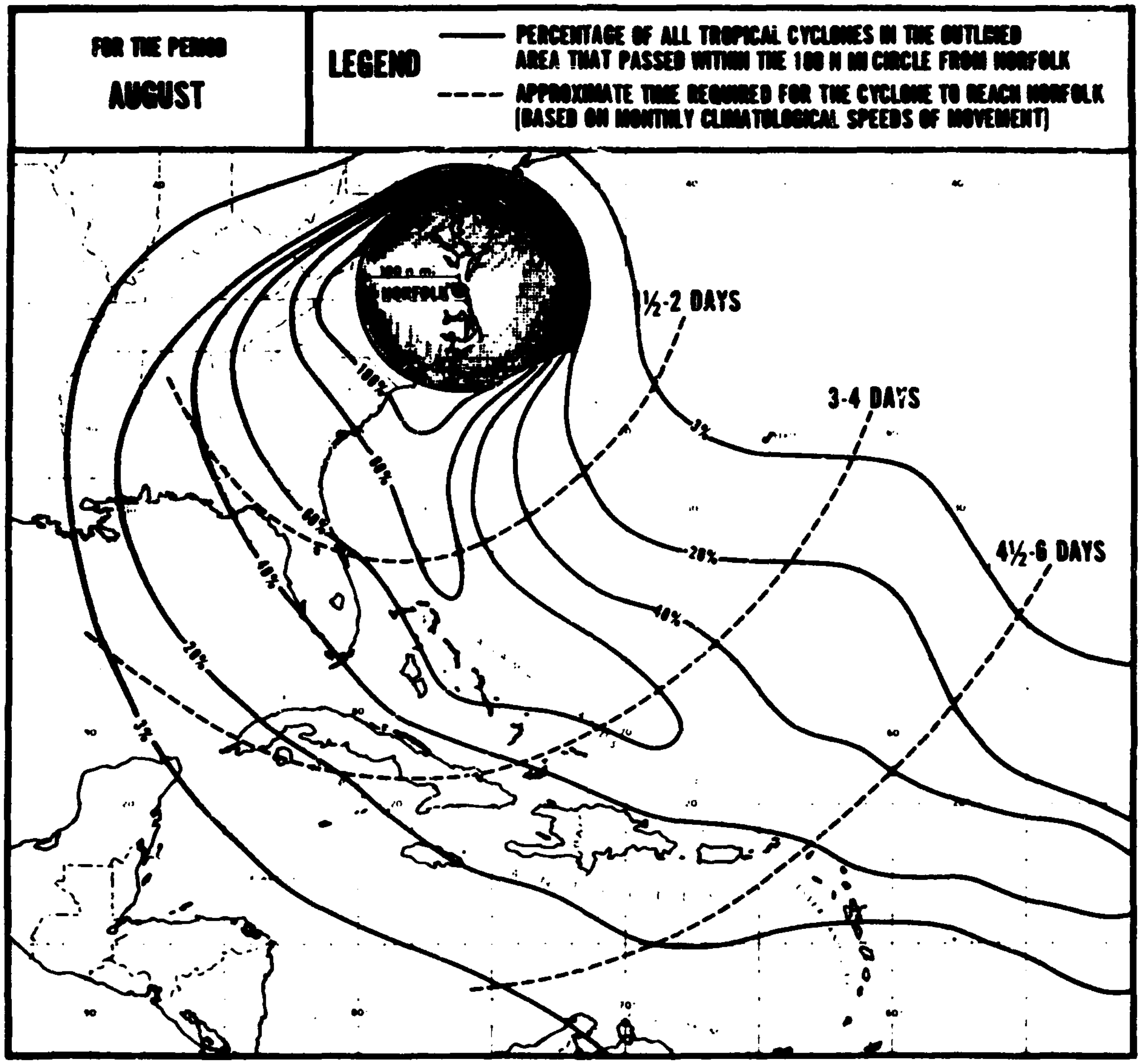

Figure II-7. Probability that a tropical cyclone will pass within 180 n mi of Norfolk during August (based on data from 1945-85).

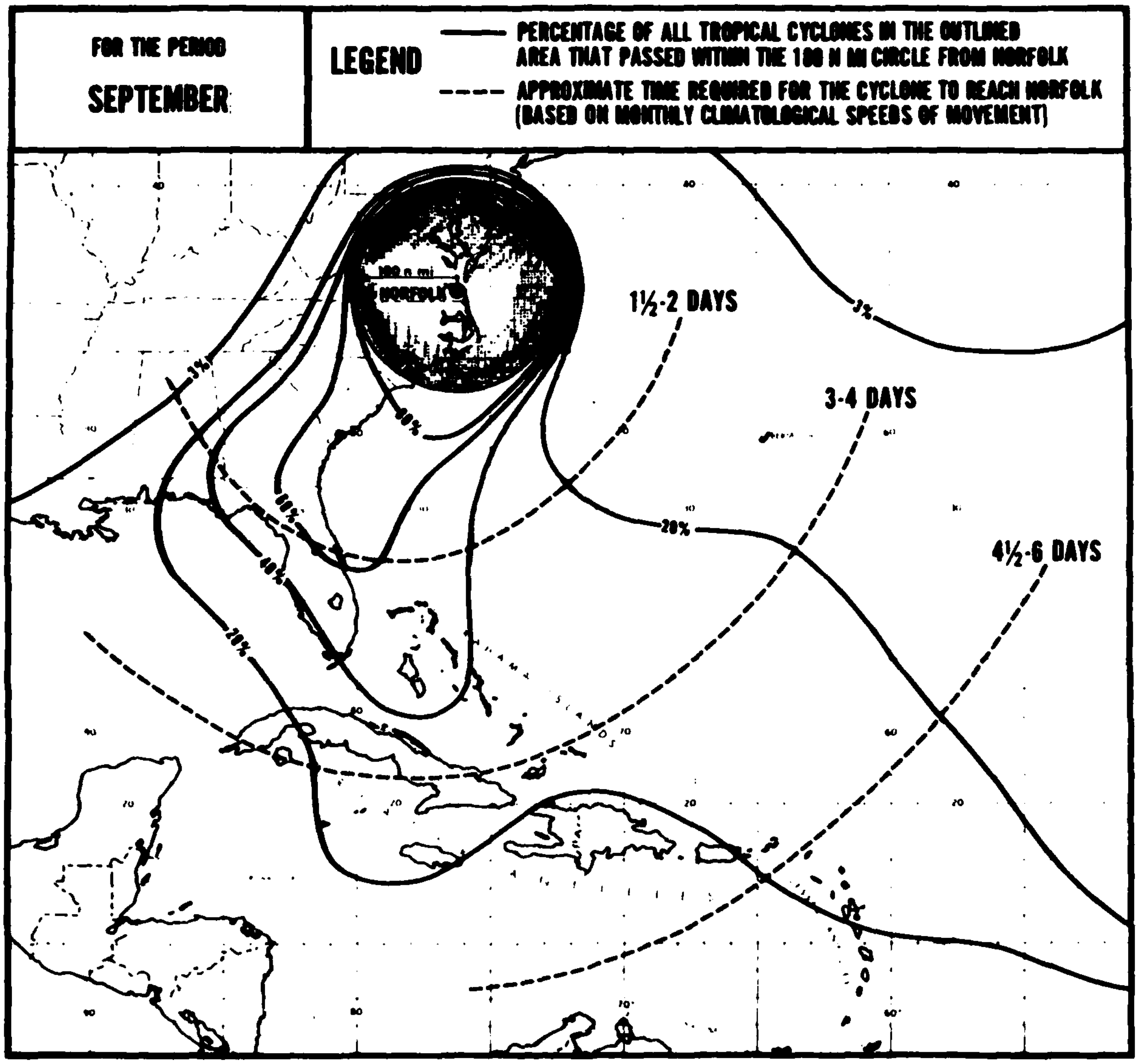

Figure II-8. Probability that a tropical cyclone will pass within 180 n mi of Norfolk during September (based on data from 1945-85).

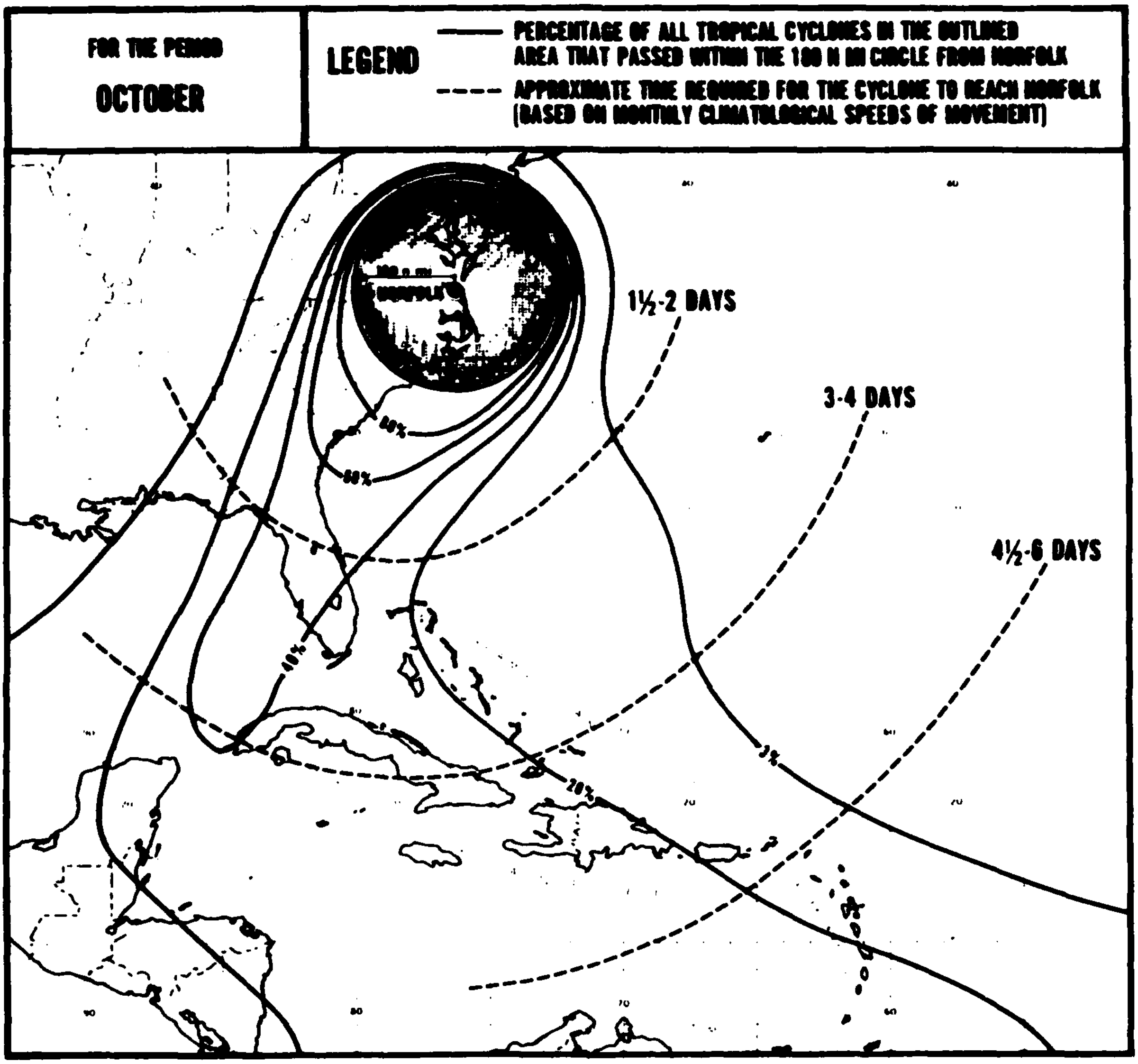

Figure II-9. Probability that a tropical cyclone will pass within 180 n mi of Norfolk during October (based on data from 1945-85).

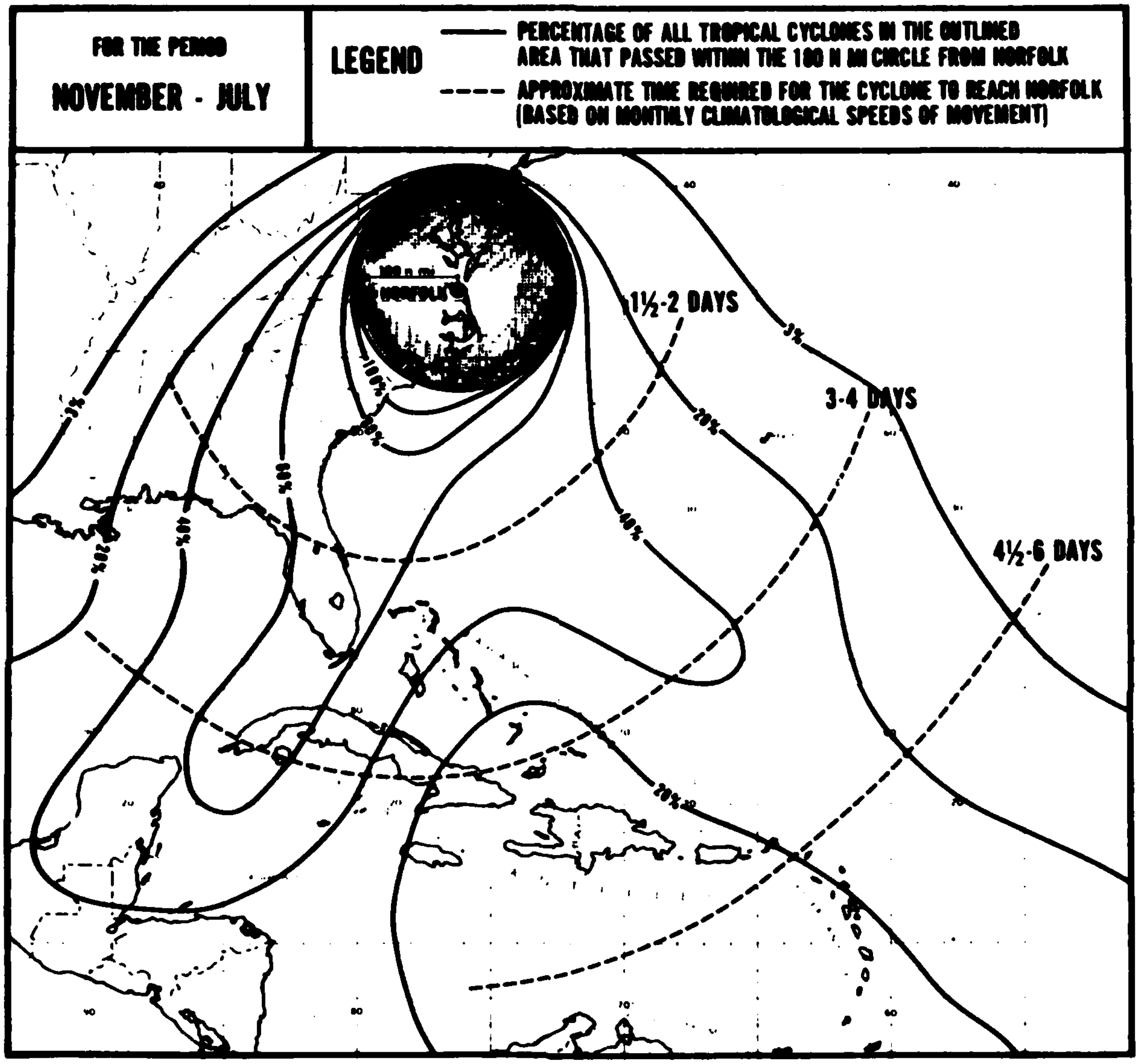

Figure II-10. Probability that a tropical cyclone will pass within 180 n mi of Norfolk during the months November-July (based on data from 1945-85).

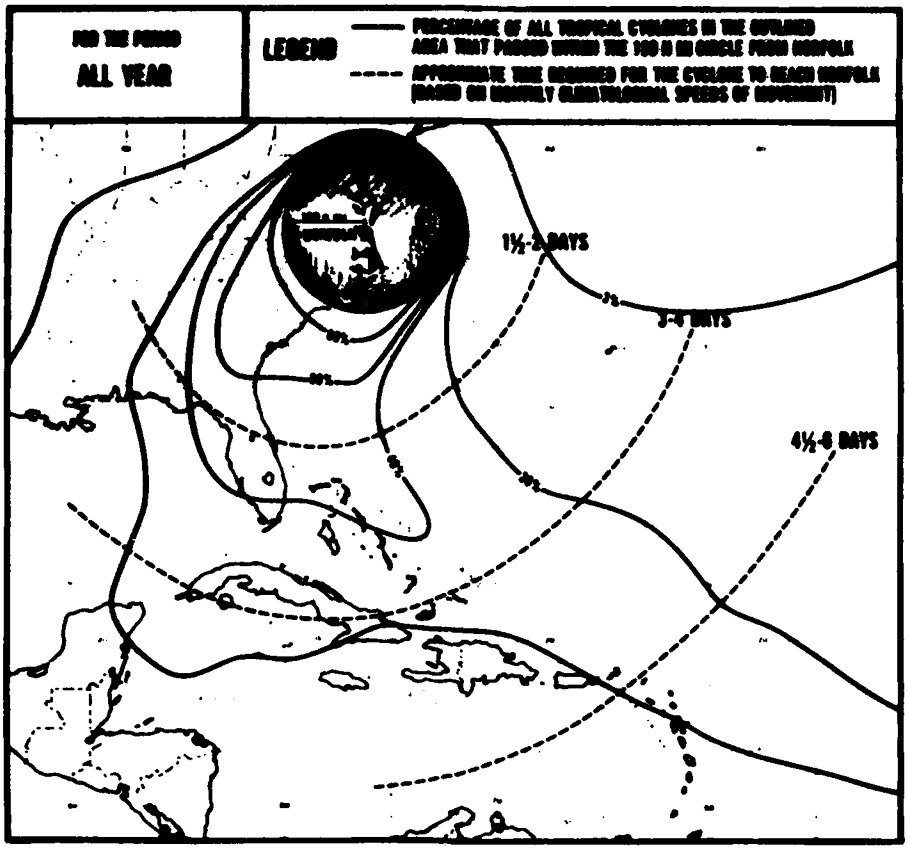

Figure II-11. Annual probability that a tropical cyclone will pass within 180 n mi of Norfolk (based on data from 1945-1985).

4.2 WIND AND TOPOGRAPHICAL EFFECTS

A tabulation of the intensity of these tropical cyclones is presented in Table II-1. The table also shows which side of Norfolk the storm passed at CPA and, consequently, infers either northerly winds (east side passage) or

Table II-1. Classification of the 61 tropical cyclones which threatened Norfolk between 1945 and 1985 by intensity at closest point of approach (CPA) and whether they passed to the east or west.

	STORM STRENGTH (KT)			
	64+ (Hurricane)	34-63 (Tropical Storm)	≤ 33 (Tropical Depression)	TOTAL
EAST	17	24	6	47
WEST	2	9	3	14
TOTAL	19	33	9*	61

*Three tropical depressions dissipated within 180 n mi of Norfolk and are not included.

southerly winds (west side passage) were *predominant*. *It can be seen from* Table II-1 that the vast majority of tropical cyclones pass to the east to give northerly winds.

The strongest recorded wind associated with a tropical cyclone at NAS Norfolk was associated with Gloria (1985) when winds reached 58 kt gusting to 79 kt. The Chesapeake Light station recorded 72 kt gusting to 79 kt with 20 foot waves. 50 kt sustained winds were recorded when Hazel (1954) came through the Norfolk area. Associated peak gusts at NAS Norfolk during the 1945 to 1985 period have been used to estimate the maximum one-minute sustained wind via the statistical relationship developed by Durst (1960) for wind spectra at level, unobstructed land sites. This reveals two other storms, Barbara (1953) and Donna (1960), which had sustained winds of 50 kt or more. Earlier records of hurricane effects at Norfolk (Ritter, 1980) suggest a similar frequency of operationally significant winds. In the period from 1900 to 1944, one and perhaps two significant occasions (both in 1933), saw sustained hurricane force winds at the NAS Norfolk and on three other occasions sustained winds of 50 kt or more were experienced. Other statistics show that hurricane force winds can be expected every six years at Cape Henry and once every 30 years at NAS Norfolk. 50 kt winds from tropical cyclones are likely to occur at NAS Norfolk once every ten years.

Thus, tropical cyclones of hurricane intensity are relatively rare at Norfolk. Of the three most destructive storms in this century, only one, Gloria-1985, can be considered typical. Gloria approached from the south, passed to the east of Norfolk then dissipated over New England. The other two destructive storms were unusual. The August 1933 storm (#8) approached Norfolk from the southeast, maintaining an over-water trajectory until striking Norfolk. In 1954, Hazel passed over land to the west of Norfolk and was actually an extratropical storm at CPA Norfolk; however, Hazel was re-enforced by a strong outbreak of cold air from the northwest and maintained its intensity. Figure II-12 shows the complete tracks of the tropical cyclones which gave gale force or greater winds at NAS Norfolk between 1945 and 1985.

Although the land in the Norfolk area is very low and featureless (the average altitude in the area is only thirteen feet above mean high water), there is some sheltering from certain directions caused by the usual surface friction with the land. Norfolk Naval Station is particularly susceptible to winds from southwest clockwise to north, and least susceptible to winds from the southeast. Naval Amphibious Base Little Creek is most susceptible to northerly winds and least susceptible to southerly winds. Norfolk Naval Shipyard has some sheltering from all directions, but any sheltering from the winds that does occur *in any of these locations* is minimal and is likely to

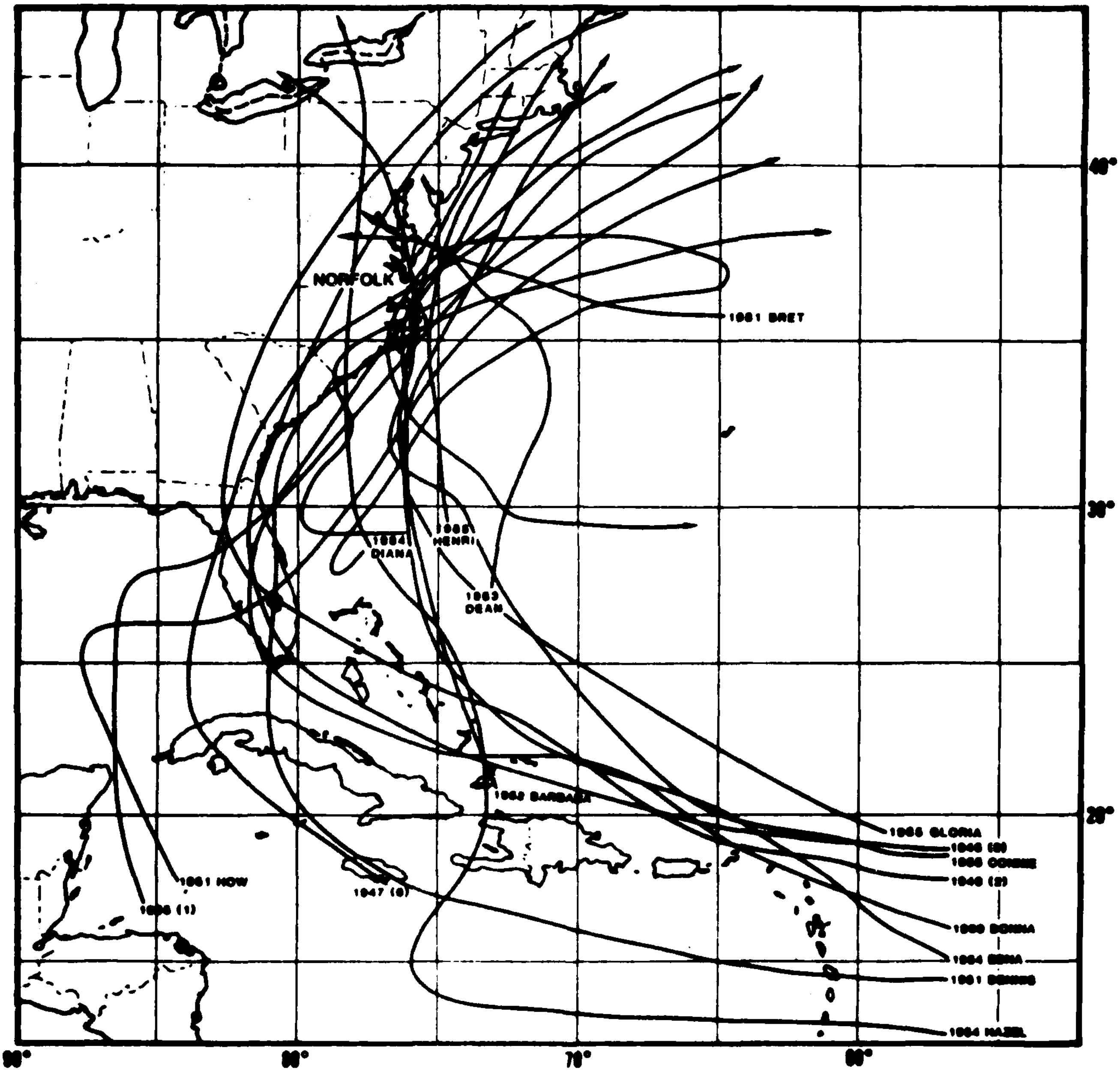

Figure II-12. Tracks of 17 tropical cyclones that produced winds of 34 kt or greater at NAS Norfolk (based on data from 1945-85).

increase the gustiness. The virtue of the Norfolk area is that, whereas little shelter is offered by topographical features, the particular combination of latitude and orientation of the coastline are unfavorable factors for encouraging strong tropical storm development and attendant strong wind conditions.

4.3 WAVE ACTION

4.3.1 Norfolk Naval Station

Norfolk Naval Station is not susceptible to waves produced by winds with an easterly component. It is also totally protected from ocean swells or even swells produced by the long fetch in Chesapeake Bay. For winds with a westerly component, a hazardous sea soon affects the piers. When the wind reaches 18 kt, a sea dangerous to small boating already exists. A rough calculation using forecasting curves from the U.S. Army Coastal Engineering Center Shore Protection Manual (1973), shows that westerly winds of 30 kt will produce 3 ft waves, 50 kt will produce 4.5 ft, and 70 kt will produce 6 ft. At the more northerly piers, 2 through 12, conditions will be slightly worse due to the deeper water just off shore. If the wind direction is such that it blows directly along the James River, then a further 0.5 ft can be added to the calculated heights. For northerly winds, conditions are much better due to the considerably reduced fetch. It therefore appears that the worst conditions for sea state at Norfolk Naval Station would arise after the close passage of the eye of the cyclone with the center lying in a direction between north and northeast. Normally, this condition will arise for tropical cyclones moving northwards up the east coast, after the center has passed Cape Henry (Figure II-1). For a tropical cyclone passing to the west to give such conditions, it would have to pass very close, and then such conditions would probably only exist for a few hours immediately after passage of the eye.

4.3.2 Naval Amphibious Base, Little Creek

The Little Creek Naval Amphibious Base is only susceptible to northerly seas generated in Chesapeake Bay. Since the southern end of the bay becomes shallow, any large waves generated in the deeper central portion will tend to break offshore. It is reported by local personnel that Chesapeake Bay can only support waves up to 8-10 ft. Waves of 5-6 ft have been experienced just outside Little Creek Harbor in winds of 40-50 kt. Inside the harbor, the waves are attenuated rapidly and only affect piers directly in line with the entrance or ships which protrude past the ends of the piers. Although relatively protected from wave action, ships with large sail areas (LST and larger) receive almost no protection from northerly winds while in Little Creek. As pier orientation lies east/west, storm winds from the north are exceptionally dangerous. To minimize this problem, piers 12-15 have been extended by 200 ft to a new total length of 620 ft to accommodate the longer vessels.

Calculations show that Chesapeake Bay could support 8-10 ft waves in a 50 kt northerly wind in its deeper central portion. The amplitude of such waves would indeed be reduced by the shallows at the southern end of the bay. In a 90-100 kt wind, it is unlikely that waves greater than 12 ft could be supported at the southern end of the bay due to its shallow nature; but conditions in the breaking waves would be treacherous. Little Creek therefore is relatively well protected from wave action, and real problems would occur during the close passage of a hurricane to the east.

4.3.3 Norfolk Naval Shipyard

Norfolk Naval Shipyard is so situated that it is not susceptible to any significant waves from any direction.

4.3.4 The Hurricane Anchorages

The hurricane anchorages described in Section 3.2 are situated in the central portion of Chesapeake Bay. The water depth there is generally between 30 feet (9.1 m) and 60 feet (18.3 m). These anchorages are somewhat protected from the build-up of large waves except when the wind is blowing parallel to the length of the bay such as a NNW or a SSE wind. With a NNW wind, the fully arisen sea is calculated to be 12 ft to 14 ft in 70 kt to 90 kt winds. Similar conditions are likely in a SSE wind. For passage of a tropical cyclone to the east, tracking northward up the East Coast, the winds are most likely to be NNW for a considerable time due to the tendency for winds to be funneled. During Hurricane Gloria, such winds caused ships with large sail area to drag anchor and come close to grounding along the Bay's eastern shore.

4.4 STORM SURGE AND TIDES

Storm surge can be defined as the difference between observed water level and expected water level at a given location during storm conditions. Due to the highly variable bathymetry and shoreline shape, surge varies considerably in this area, even over short distances. Other factors affecting the water level are direction, velocity and persistence of the wind; the atmospheric pressure; and water transport by waves, swell, and rainfall. Therefore, the actual surge to be expected will be difficult to forecast. The National Weather Service has developed computer prediction models, and will issue storm surge forecasts as appropriate. The approximate surge height to be expected can be estimated from past experience. The highest surge that occurred in the Norfolk area was 6.2 ft, recorded at the Sewells Point gage in August 1933. The maximum sustained wind at the time was approximately 60 kt from the northeast. Because this surge occurred during high tide, the actual tide height was 9.7 ft. Such a surge would not only be a disaster for many ships, but would be a catastrophe for the low lying land areas. The maximum predicted surge using a computer model of the worst possible situation is approximately 11.5 ft at Cape Henry. This would result from a hurricane with maximum winds of 120 kt moving due west towards Norfolk and making landfall approximately 15 mi south of Cape Henry (Figure II-1). Such a hurricane would cause northeasterly winds for a considerable time, especially if it was slow moving. The Norfolk area is most susceptible to high surges when strong northeasterlies are coincident with high tide. A surge with less amplitude will occur with north or east winds. For other wind directions, southeast through southwest to northwest, a large surge is unlikely. Winds from the south quadrant, however, can cause a negative surge, resulting in lower than predicted tides.

Tides in the vicinity of Norfolk are normally not a problem. The mean tidal range in Hampton Roads is 2.5 ft and 2.8 ft at Cape Henry. Current velocities in the area range from 0.5 kt in the Elizabeth River to 1.0 kt at Hampton Roads. Cape Henry has a 1.0 flood tide current and a 1.5 kt ebb tide current. The entrance to Chesapeake Bay, off Cape Henry, can experience a 3.0 kt current during storm conditions. These values are considerably influenced by the wind and, under surge conditions, may well exceed the tabulated values by several knots. At Little Creek, the normal current flow is 0.5 kt to 1.5 kt. This is reported to increase to as much as 6.0 kt with a 40 kt to 50 kt northerly wind during flood tide. In hurricane conditions, all these current velocities will be increased still further and will be a considerable hazard to ship movement.

5. THE DECISION TO EVADE OR REMAIN IN PORT

Specific instructions to ships for coping with severe weather are contained in COMNAVBASE NORVA/SOPA (ADMIN) HAMPTON INSTRUCTION 3141.1P, DESTRUCTIVE WEATHER PLAN. This instruction sets forth guidance and procedures to be employed by commands in the SOPA Hampton Roads area concerning destructive weather such as tropical storms, tornadoes, etc. Definitions of Tropical Storm/Hurricane Conditions are given, along with the status of preparedness and action required to achieve each condition of readiness.

5.1 EVASION RATIONALE

The most important aspect of any decision concerning heavy weather is an early appraisal of the threat posed by an individual tropical cyclone.

Historically, tropical cyclones which cross Florida or the Bahama Islands and finally recurve northward have a relatively high probability (40-60% annually) of passing with 180 n mi of Norfolk. Any decision to sortie from Norfolk must be made early to gain maneuvering room in the open ocean, especially since large swells are likely to precede the storm by 12-36 hours and hamper ship's speed of advance.

An unfortunate aspect of an early decision is that, at that time, tropical cyclone forecast errors will be greater, including the center position, intensity and track. The tendency may be to delay any evasion decision while waiting for updated, more accurate forecast data. By then, it may be too late for safe evasion.

5.2 REMAINING IN ALONGSIDE BERTHS

Remaining in port when the means for storm evasion are available is a decision contrary to most of the traditional rules of seamanship. The final decision, however, will depend on many factors, including the forecast wind intensity at the port and the track of the storm. Characteristics of any particular harbor must also be taken into account for each individual ship. Smaller ships can usually ride out a storm in a sheltered harbor if proper lines are used, but larger ships should evade at sea. Some factors to consider are given in the following paragraphs.

5.2.1 Norfolk Naval Station

(a) Norfolk Naval Station is not a haven for carriers. When sustained winds of 50 kt or greater are expected, carriers should sortie at the earliest opportunity and evade at sea.

(b) Large ships (larger than frigate size), especially those with large sail areas, should also evade at sea when winds 50 kt or greater are expected.

(c) Smaller ships should sortie on the rare occasions when hurricane winds ($\geq$64 kt) are expected.

(d) Small boats and service craft should be removed from the water when gale force winds are expected. If this is not possible, evacuate to the Norfolk Naval Shipyard.

(e) Those ships seeking shelter in the harbor in any conditions should obtain a berth on the windward side of the pier when possible. Ships should increase the number of lines, and keep a close watch on the lines in case of storm surge. The maximum storm surge will not necessarily occur at the same time as the strongest winds.

(f) Wave conditions will be far worse for any particular wind strength if the wind has a westerly rather than an easterly component.

(g) Storm surge will be at its worst with high seasonal tides and north-easterly winds.

5.2.2 Naval Amphibious Base, Little Creek

(a) The controlling depth is only 18 ft (5.5 m) and the harbor is normally only used by amphibious ships and salvage/rescue vessels.

(b) The harbor provides good protection from sea and swell, but not necessarily from wind and storm surge, especially with a northerly wind. Ships with large sail areas (LPD's, LST's, etc.) should evade at sea if possible.

(c) Ships at Little Creek will normally sortie only if a sustained wind is forecast that will make the berths untenable. This will vary for each ship, but is expected to be a rare occurrence (60+ kt).

(d) The best berths will be on the windward sides of the piers, ensuring that ships do not protrude past the end of the pier.

(e) Small boats and service craft should be removed from the water if possible.

5.2.3 Norfolk Naval Shipyard

(a) Most ships will not be in a position to sortie and should be secured as well as possible.

(b) There will be a great demand for berths and tug assistance. Requests and movements should be made early in order to avoid last minute confusion.

(c) Any large storm surge will cause an enormous problem, and a watch should be kept at all times to avoid boats breaking their mooring lines and becoming a problem for other vessels.

5.3 ANCHORING IN CHESAPEAKE BAY

Use of the hurricane anchorages in Chesapeake Bay will normally be confined to smaller ships that decide to sortie from the Naval Station, Little Creek or the Shipyard and are unable to evade at sea. They may also be used when the harbors are expected to become marginally unsafe and evasion at sea would be difficult or uneconomical. In any case, the following factors should be noted:

(a) The mud and sand bottom is considered fair to good holding ground.

(b) Maximum wave heights will be between 10 and 14 feet for northerly winds of hurricane strength; and for winds not along the axis of the bay, wave heights will be considerably less.

(c) As noted in the SUMMARY preceding, there is a possibility of ships dragging anchor and becoming a hazard to other ships at anchor. A second anchor should be ready for dropping at any time. During Hurricane Gloria even ships with two anchors out continued to drag.

(d) There is a high probability that some of the numerous small vessels and barges seeking shelter in the upper part of the Chesapeake Bay will be improperly secured and will come adrift. These drifting hulks will be a deadly threat to any ships anchored in their path.

(e) The bottom depths are convenient for anchoring (except in the shipping channels), and should provide adequate underkeel clearance even in high seas.

(f) Maximum separation between occupied anchorages will minimize the damage threat should ships drag anchor or break loose. Note, however, that few good radar targets exist in the region making precise ship positioning difficult, and poor to non-existent visibility during storm conditions prohibits visual determination of position.

5.4 EVASION AT SEA

Evasion at sea is the recommended course of action for frigate size ships and larger when tropical storm conditions are expected. It should be noted that due to the latitude of Norfolk and the orientation of the coastline, conditions of this sort are rare at the piers and would normally only be expected if an intense tropical cyclone was threatening to track close to the Norfolk area. When evasion is contemplated, it is important to correctly assess the threat posed and act quickly to ensure flexibility. The nature of the coastline makes an early departure imperative if a real threat is imminent.

Once the determination to sail is finalized, an assessment of the best course of action at sea must be made. The ship's Captain, with his detailed knowledge of his ship and crew, must always make his own personal decision as the situation dictates. The following describes the most likely threat situations and the recommended courses of action. In reality, each threat must be considered on its own merits.

(a) A TROPICAL CYCLONE MOVING ALONG THE COAST FROM THE FLORIDA AREA AND FORECAST TO PASS TO THE EAST - This is the most common threat and carries the possibility of high surges. Unfortunately it is also the most difficult to evade. First, an early departure is imperative to be able to cross ahead of the storm. There is little choice but to steam on an easterly heading to gain maneuvering room. This is likely to be followed by heading southeastward to make use of the likelihood that the storm will recurve and accelerate on a northeasterly track.

(b) A TROPICAL CYCLONE MOVING UP FROM THE FLORIDA AREA AND FORECAST TO PASS TO THE WEST OF NORFOLK - This situation is less common and does not pose as great a threat as case (a). Although Hurricane Hazel (1954) passed west of Norfolk and caused winds of 50 kt gusting to 85 kt at NAS Norfolk, most storms passing to the west weaken due to their track over land. Winds will generally be southeasterly veering to westerly as the storm passes. To justify evacuation, the expected CPA would have be very close (within 60 n mi) or the cyclone would have to be very intense, similar to Hazel. Evasion is also relatively easy. Ships should steam southeastward after departing Chesapeake Bay.

(c) A TROPICAL CYCLONE MOVING NORTHWEST AND FORECAST TO PASS NORTH OR WITHIN 100 N MI SOUTH OF NORFOLK - Although such a threat is rare, it has happened in the past. In August 1933, the worst storm surge ever recorded was caused by such a storm. Two other tropical storms of less intensity, Bret (1981) and Dean (1983), also fall into this category. For early evasion, a track past Cape Hatteras and southwestward towards Florida is the optimum route. This must be accomplished prior to a build-up of the seas or forward progress will be impaired. For later evasion, problems will mount rapidly. If the evasion route around Cape Hatteras becomes impossible, there is no other choice but to steam northeastward into headwinds and seas. Progress will be slow and the cyclone may recurve and accelerate to the north or northeast.

Other cases will have to be considered individually. Also, a close watch must be kept on all warnings even after the danger has apparently passed. There is always a possibility of a tropical cyclone stalling or looping to rethreaten an area.

5.5 RETURNING TO HARBOR

After the passage and successful evasion of a tropical cyclone, returning to harbor is itself not without hazard. There may well be sunken wrecks in the channels, there may be damage to piers, and some services may be disrupted or non-existent. Also there is a high probability that channel markers and other navigation aids have shifted position or have become otherwise unreliable. The utmost caution must therefore be taken.

6. ADVICE FOR SAILING BOATS AND SMALL FISHING VESSELS

Sailing boats and small fishing vessels obviously must seek shelter in a harbor when tropical storm or hurricane-force winds are forecast. The best solution is to remove the boat from the water altogether at the earliest opportunity and secure it well away from the effects of possible surge. For those unable or too late to remove their vessels from the water, they should locate well protected berths or moorings before the start of the hurricane season. Within the Norfolk area there are many tributaries of the Elizabeth River, especially the southern branch where small boats can find shelter. It must be remembered, however, that the boat should be tended throughout the threat period in order to prevent the breakage of mooring lines if a surge occurs.

Chesapeake Bay Hurricane Holes

The following is extracted from the "The Chesapeake; A Boating Guide to Weather," by Jon Lucy, Terry Ritter and Jerry LaRue published in 1979:

> Although hurricanes are rare in Chesapeake Bay, near-hurricane force winds (greater than 63 kt) are not uncommon because of severe thunderstorm activity and summertime squalls. This makes it important for boatmen to know the location of well-protected harbors that provide good landlocked water with adequate depth for deep-draft vessels. So-called "hurricane holes" are present in most Bay tributaries, according to Julius Wilensky in "83 Hurricane Holes of the East Coast" (Sea Magazine, August 1978). Locations of hurricane holes follow (Fig. II-13), as recommended by Wilensky and Jon Lucy (indicated by an asterisk).

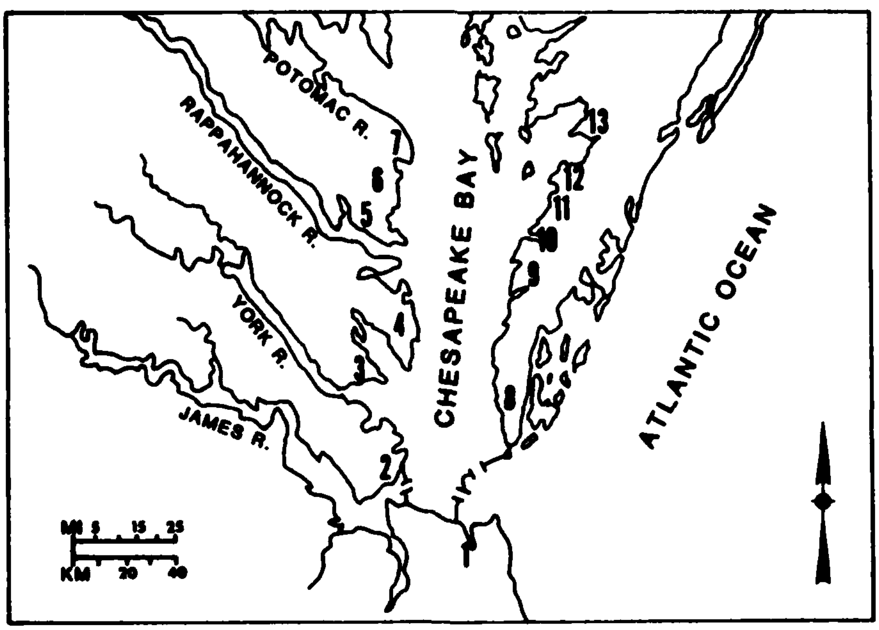

Figure II-13. Some Chesapeake Bay hurricane holes that provide good vessel anchorages during high-wind periods (after Lucy et al., 1977).

Lower Bay (South to North)

Western Shore

1) Linkhorn Bay, off Lynnhaven Bay above Cape Henry -- Enter Lynnhaven Inlet cautiously because of a shifting bar, but anticipate a well-marked entrance channel with water depths of 6-10 feet (1.8-3 meters); the Inlet and the east channel towards Linkhorn Bay are crossed by fixed bridges with 35 foot (10.7 meter) clearances; after entering the Inlet, swing wide to the left towards the Great Neck Road Bridge and proceed into Broad Bay, then through the 6 foot (1.8 meter) deep Narrows into Linkhorn Bay; protected anchorages can be found in both the south and east branches of the Bay to either side of the Bird Neck Point, with shoreside facilities at the ends of each branch.

2) Hampton River, north shore inside Hampton Roads* -- Cross Hampton Roads Bridge Tunnel and enter the channel to the right behind the Tunnel Island; as you enter the mouth of Hampton River, be on the lookout for commercial tug and barge traffic; proceed up Sunset Creek on the left where two marinas handle limited numbers of transient boats; do not anchor in the Hampton River channel because of barge traffic and the River's northeast orientation.

3) Lower York River, north shore* -- after passing Sandy Point, Look for day markers indicating the winding channel into the Perrin River where dockage can be found at the large marina. Drafts of seven feet (2.1 meters) can be accommodated. Even better protection is offered further up the river in Sarah Creek where good anchorages with water depths of 7-8 feet (2.1-2.4) meters) are available in the northwest branch up to the repair yard and marina, and the northeast branch as far as the oyster packing house on the north shore.

4) East River, off Mobjack Bay -- Anchor either in Putam Creek or in East River itself, south of Woodas Point.

5) Corrotoman River, lower Rappahannock River, north shore -- After clearing the power cables (50 foot or 15.2 meter clearance) along the Grey's Point bridge, anchor in either of the Corrotoman's branches; 7 foot (2.1 meter) drafts can be carried 2 1/2 miles (4 kilometers) up the east branch, while the west branch can handle 8 foot (2.4 meter) drafts for the same distance.

6) Dividing Creek, north of Fleets bay, about midway between Rappahannock and Potomac Rivers -- Anchor up the creek just above Lawrence Cove.

7) Horn Harbor, about 5 miles (8 kilometers) up Great Wicomico River, north shore -- This is the best of several well protected creeks going upriver.

Eastern Shore

8) Cape Charles Harbor* -- This harbor of refuge located nine miles (14.5 kilometers) north of the Cape itself can provide protection with transient docks located in the northeast corner behind the Coast Guard Station; for boats drawing less than five feet (1.5 meters), Kings Creek just north of the harbor also offers protection as well as marina services, but the channel markers must be followed carefully.

9-10) Occohannock and Nandua Creeks* -- Some protection can be found in Occohannock Creek up to the area of Davis Wharf, beyond which water depths drop below 7-8 feet (2.1-2.4 meters). Nandua Creek to the north has a somewhat tricky, winding channel bordered by shoals, but with care, protection can be found by running up to Nandua.

11-12) Pungoteague and Onancock Creeks* -- Good protection is found up Pungoteague Creek in the area of Harborton; further north Onancock Creek provides good storm anchorage in the area of the Onancock town dock.

11) Saxis, upper Pocomoke Sound* -- Protection is available in the commercial fishing harbor for boats requiring depths of 6 feet (1.8 meters) or less.

The anchorages mentioned here may be crowded because of their popularity. If you must look elsewhere for good protection, look for bodies of water in which an extra high tide up to 12 feet (3.7 meters) above mean high was can be handled. If you are actually expecting the eye of a hurricane to come ashore in your area, the best protection in the Northern Hemisphere is in the left rear quadrant with respect to where the storm's eye is expected to intersect the coast approaching storm along its projected track).

In seeking protected anchorages, remember that a hurricane usually will produce east or northeast wind speeds of 70-100 kt followed by lesser wind from the west or northwest. A hurricane's high winds and tides also require that anchor line scope be increased from the usual 7:1 ratio to a 10:1 ratio. If a protected harbor has limited swing room for anchored craft, two anchors should be used 180 opposed to each other. Reduce the likelihood of dragging by anchoring in sand or hard mud rather than grassy bottom or soft mud.

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